CARDAMOM, GINGER AND TURMERIC

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Keywords: *Amomum subulatum, Curcuma longa*, capsules, cardamom, disease, *Elettaria cardamomum,* ginger, large cardamom, pests, small cardamom, turmeric, *Zingiber officinale*

Contents

Summary

Cardamom, ginger and turmeric belong to the family Zingiberaceace. Cardamoms are the dried fruits of perennial herbs. They are one of the highest priced and most expensive spices after saffron and vanilla. The seeds have a pleasant aroma and a characteristic warm, slightly pungent taste. There are two kinds of cardamoms found in the spice world. True cardamom (or small) cardamom belongs to the genus *Elettaria*. Large cardamom, Nepal cardamom or the black cardamom belongs to the genus *Amomum*.

Both cardamoms are shade loving plants usually cultivated under forest trees at altitudes between 700-1500m above sea level. Dried capsules are the commercial parts used, especially the seeds. Seeds of cardamom contain 6-8% essential oil, but seeds of large cardamom contain less than 3.5% oil. Large cardamom seeds have a harsh note with a camphor aroma. These are indigenous to Sikkim and other parts of the Himalayas, and are mainly used in spice mixes.

Ginger belongs to the genus *Zingiber* and turmeric to *Curcuma*. In both plants the underground stem (rhizome) is the commercial product. Ginger contains about 1.5-2.5% volatile oil, mainly zingiberine that contributes to the aroma. The oleoresin content varies from 4 to 10% known as gingerol that contributes to the taste and smell. Turmeric is valued for the yellow pigment curcumin (diferuloylmethane) which varies from 4 to 8% in the dried rhizomes. Curcumin in turn contains curcumin I (almost 94%), curcumin II (6%) and curcumin III (0.3%).
Zingiberaceous spices are known for their medicinal properties in the traditional systems of medicine in Asia. There are several pharmacological applications for these spices.

1. Introduction

Spices are the aromatic substances of vegetable origin used as preservatives and food flavors. Spices are obtained from various plants and are used in food, beverages, cosmetics and confectionary. The plant parts that are used vary from fruits to seeds, flowers and bark. The family Zingiberaceae comprises four to five genera that are commercially important, namely *Amomum, Curcuma, Elettaria* and *Zingiber*. Other species such as *Alpinia galanga, Z. zerumbet*, and *Z. cassmunar* are used both as spices and in traditional medicine. In the case of cardamom the fruits are dried and used whereas in case of ginger and turmeric the rhizome is the economic part.

These spices have originated in the tropics and subtropics and have been used for centuries for their aroma, flavor and color. The essential oil and oleoresin that impart their quality are well documented (Weiss, 2002)**,** and these ingredients are often extracted and exported.

2. Small Cardamom

Cardamoms are the dried fruits of the perennial herb *Elettaria cardamomum* Maton, belonging to the ginger family Zingiberaceae. These are also known as small cardamom or true cardamom, and are referred to as 'Queen of Spices'. Small cardamom dominates the world trade for this spice. The Cardamom seeds have a pleasant aroma and a characteristic warm, slightly pungent taste.

Small cardamom is indigenous to South India and Sri Lanka, where it grows in evergreen rain forests at altitudes between 700 and 1500m. India was the world's largest producer of cardamom until 1979-80. Later, Guatemala emerged as the premier producer and exporter, accounting for about 90% of global trade. Cardamom is also grown in reasonable quantities in Sri Lanka, Papua New Guinea and Tanzania.

Cardamom is widely used in Asian cooking. It is an essential ingredient in *garam masala* and is also used as a breath freshener. It is common to chew a seed or two after a spicy meal. It is also believed to aid in digestion. Recent studies suggest that cardamom may prevent teeth cavities. In the Middle East, cardamom is widely considered as an aphrodisiac. Scandinavians still use cardamom to spice their "Danish pastry" and other deserts, as well as meat dishes like Swedish meatballs. Cardamom also features prominently in German cookies.

In South and South East Asia cardamom is an ingredient in betel nut chewing. It is very common to use tinctures of cardamom in medicines for windiness and is beneficial to stomach problems. Powdered cardamom seeds are invariably mixed with ground ginger, cloves and caraway and used mainly for combating digestive ailments. It is used as a powerful pleasant aromatic stimulant, carminative, stomachic and diuretic. In the present day stress-prone population cardamom is often used as a cardiac stimulant.

2.1. Origin and Distribution

The earliest reference to cardamom is a clay tablet from the ancient city of Nippur, Sumaria, dated 2000 BC (Weiss, 2002). Cardamoms are reportedly described in the *Ayurvedic* literature in India (3^{rd} century BC), where they were recommended for stomach and urinary disorders. Cardamom was an article of trade between India and Greece during the 4^{th} century BC. Inferior grades were known as *amomon*, superior ones as *kardamomon*, but it is still debated whether these were the same cardamoms or just those currently known as the large and small cardamom of today.

References to the use of cardamom in ancient literature are scanty compared to spices like black pepper, cinnamon or cassia. Cardamom was a natural forest product until the early 19^{th} century, and its large scale organized cultivation started only in the mid 19^{th} century when the demand for cardamom increased worldwide. Nowadays cardamom

production is concentrated mainly in India and Guatemala. India has been the largest producer, consumer and exporter till 1980, but afterwards its position was taken over by Guatemala. In the latter country the crop was introduced in 1920, and its production considerably expanded after World War Two due to high market prices and the drop of coffee prices.

There is no domestic consumption of cardamom in Guatemala and, therefore, the entire production is exported. Currently, Guatemala produces about 20,000-30,000 tons annually. India stands next in production with about 11,000-12,000 tons annually, but as the internal consumption is very high in India only 600-800 tons are exported (Table 1).

Country	Area (hectares)	Production (tons)	Export (tons)
Guatemala	58,300	24,000	23,693
India	71,170	11,000	750

Table 1. Area, production and export of (small) cardamom in 2008-09 (Source: www.indianspices.com; and Banco-de-Guatemala reports-www.banguat.gob.gt)

2.2. Plant Description

The cardamom plant is a 2-4 m tall herbaceous perennial with branched subterranean rhizomes from which several leafy shoots arise, forming a clump. Leafy shoots have a limited life span; the first year is mainly for vegetative growth, the second year for reproductive growth (flowers and fruits), and the third year a senescence and death stage. New buds are formed from the base of the old shoots in the first and second year and thus, in a clump of old shoot. Young shoots and buds can be seen in varying numbers. Flowers are borne on erect, prostrate or semi-erect (flexuous) inflorescences depending on the variety.

The leaves are lanceolate in shape, and lamina tapers into a sharp tip, 25-90 cm long and 5-15 cm wide. Leaves are dark green and shiny on the upper surface and pale green on the lower surface. The lower surface of the leaf could be smooth (glabrous) or pubescent (hairy) depending on the variety. The inflorescence arises from the base of the leafy shoots and is 45-120cm long. Flowers are borne in racemes, they are hermaphrodite, zygomorphic and about 4cm long and 1.5cm wide. The calyx is tubular green and shortly three-toothed and persistent. The corolla tube is as long as the calyx tube, with narrow spreading pale green lobes.

Flowers have an attractive petalloid labellum which is made of modified stamens, about 1.8 cm long with an undulating edge. The labellum is white in color with violet streaks radiating from the center. There is only one functional stamen which has a short, flat, broad filament, with a longer anther and connected with a short crest. The inferior ovary consists of three united carpels with numerous ovules in axile placentation and a slender style with a small capitate stigma which sits on the top to the anther along the crest.

Flower initiation takes place along with the onset of the rains (March-April in India). From initiation to full bloom it takes 25 to 35 days, and from bloom to maturity, 110 to

140 days. The fruit is a trilocular capsule, ovate-globose, dark green to pale green in color. On ripening the capsule turns yellow in color; it contains 15-30 seeds which are dark brown, angled, aromatic and about 3mm long with a thin mucilaginous aril.

2.3. Botany

The genus *Elettaria* has seven species. The (small) cardamom of commerce belongs to the genus *Elettaria* and species *cardamomum*. Based on the nature of the plant, panicle, shape and size of fruits, three types of cultivated varieties can be recognized in India: var. *Malabar*, *Mysore* and *Vazhukka*. In the *Malabar* variety the plant is medium sized, 2-3m high, with leafy shoots. Generally, the leaves are hairy on the lower surface. The panicles are prostrate and 60-90 cm long: the fruits are small, globose, round or ovoid, pale green in color and are ribbed. This variety is best adapted to areas 600m to 1200m high. The variety *Mysore* comprises robust plants attaining 3-4m height. Leaves are large, lanceolate to oblong lanceolate and glabrous on both surfaces. Panicles are erect and capsules are bigger, longer, fusiform, three angled, dark green in color and ribbed. This variety is better adapted to altitudes between 900 and 1200m. This variety is mainly cultivated in the Indian states of Kerala and Tamil Nadu.

Figure 1. Cardamom growth habit and varieties: a) Cardamom under forest shade in India; b) Cultivated in open areas in Guatemala; c) *Malabar* with prostrate panicles; d) *Mysore* with erect panicles; e) *Vazhukka* with semi-erect panicles; f) Young plant with tillers; g) Long panicles kept circled to facilitate inter cultural operations (India).

The variety *Vazhukka* is robust and resembles the Mysore variety. Panicles are semi-erect (flexuous) in nature. Leaves are broad, lanceolate to oblong, and glabrous on both surfaces. Capsules are bold, dark green in color, ovoid in shape, three-angled and ribbed. This variety is also adapted to altitudes between 900 and 1200m. It is extensively cultivated in Guatemala (Fig. 1).

2.4. Breeding

The basic chromosome number of *Elettaria* is x =12 and the somatic chromosome number is 2n= 48 or 52. Cardamom is cross-pollinated, and a large variability exists in seedling progenies. Germplasm is collected and maintained at various research institutes, such as the Research Institute for Spices and Medicinal Plants in Bogor, Indonesia; the Indian Institute of Spices Research (IISR) at Calicut; and the All India Coordinated Research Project on Spices (AICRPS).

Selections and hybrids have mainly been made for yield improvement and resistance to pests and diseases. Plants with medium stature and prostrate panicles are more suited for closer planting and (3000 plants per hectare), whereas robust plants with semi-erect panicles are suited for low density planting and intensive management practices (1000 plants/ha). Hence, quite a number of location- specific varieties have been released in various countries, many of which yield more than 1000 kg /ha.

2.5. Ecology and Growing Conditions

Cardamoms are shade loving plants; overhead shade is generally provided by forest trees. They grow well in places receiving a well distributed rainfall throughout the year, and with temperatures ranging between 10° and 35° C. In India cardamom is cultivated at altitudes between 700m and 1500 m along the Western Ghats with an annual rainfall 1500-3000mm. In Sri Lanka growth concentrates mainly at altitudes above 1,000 m. Cardamom cultivation is mainly rain-fed and depends largely on the monsoon rains. In areas where, due to climatic change phenomena, rains have become less predictable and temperatures are increasing, over-head sprinkler irrigation may become necessary. In Guatemala, cardamom growing areas receive about 2,000 to 5,000 mm rainfall per annum, and the rainfall is generally well distributed over 170 to 200 days in a year. Average temperatures are cooler than in India and Sri Lanka. Cardamoms prefer well drained soils rich in organic matter; the crop does not tolerate water logging. Most suitable cardamom soils have a sandy clay to sandy clay loam texture, and are acidic in nature (pH 4.5-5.8); these soils are often deficient in zinc, boron, molybdenum and manganese.

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Bibliography

Chempakam, B. and Parthasarathy, V.A. (2008). *Turmeric*. In: Villupanoor, A. Parthasarathy, B. Chempakam and J. Zachariah, T., eds.: *Chemistry of Spices.* CABI International, Wallingford, UK., 97-123. [A volume contributed by many authors for compiling information on spices-derived natural products. The chemical structures of various compounds and their uses are discussed].

DASD. (2007) *Arecanut and Spices Database*. Directorate of Arecanut and Spices Development, Calicut, India, 110p [Gives statistics on spices production in various spice growing states of India and export].

Ishita, C., Kaushik Biswas, Uday Bandyopadhyay and Ranajit K. Banerjee (2004). *Turmeric and Curcumin: Biological Actions and Medicinal Applications.* Current Sci., 87 (1): 44 - 53. [Describes the various medicinal application of turmeric and their active ingredients].

Kandiannan, K. and Chandaragiri, K.K. (2006). *Influence of Varieties, Dates of Planting, Spacing and Nitrogen Levels on Growth, Yield and Quality of Turmeric* (*Curcuma longa*). Indian J. Agric. Sci., 76 (7): 432 -4. [A research paper on various agronomic aspects described].

Kumar, A., Anandaraj, M. and Sarma, Y.R. (2005). Rhizome Solarization and Microwave Treatment: Ecofriendly Methods for Disinfecting Ginger Rhizomes. In: Prior, P., Allen, C. and Hayward, A.C., eds: Bacterial Wilt and Ralstonia solanacearum Species Complex. American Phytopathological Society Press, p185 -196. [Describes modern disinfection methods for ginger].

Nybe, E.V. and Mini Raj, N. (2005). *Ginger Production in India and Other South Asian Countries*. In: Ravindran, P. N. and Nirmal Babu, K., eds.: *Medicinal and Aromatic Plants – Industrial Profiles: Ginger: The Genus Zingiber*. CRC Press, Washington, 41. pp. 211-240.. [The cultivation aspects of ginger starting with seed rhizomes to harvest are described including nutrition requirement].

Okwuowulu, P.A. (2005). *Ginger in Africa and the Pacific Ocean Islands*. In: Ravindran, P. N. and Nirmal Babu, K., eds.: *Medicinal and Aromatic Plants – Industrial Profiles: Ginger: The Genus Zingiber*. CRC Press, Washington. pp. 279-303. [The cultivation aspects of ginger in Nigeria and Pacific Ocean Islands are described].

Purseglove, J.W., Brown, E.G., Green, C.L. and Robbins, S.R.J. (1981) *Turmeric*. In: Purseglove, J.W., ed.: Spices. Volume 2, pp. 532-580. Longman Group Ltd, London. [A detailed description of origin, spread and cultivation practices for spices are given].

Rao, Y.S., Anand Kumar, Sujatha Chatterjee, Naidu R., and George, C.K. (1993) *Large Cardamom (Amomum subulatum* Roxb.) *A Review*. Journal of Spices and Aromatic Crops 2 (1 and 2): 1-15. [Overview of growth and production of cardamom with a focus on Indian conditions].

Ravindran, P.N. and Madhusoodanan, K.J. (2002). *Cardamom - The Genus Elettaria*. Taylor and Francis Publishers, London. [A multi-authored volume on various aspects reviewing the information available on cardamom].

Ravindran, P. N., Nirmal Babu, K. and Shiva, K. N. (2005). *Botany and Crop Improvement of Ginger*. In: Ravindran, P. N. and Nirmal Babu, K., eds.: *Medicinal and Aromatic Plants – Industrial Profiles: Ginger: The Genus Zingiber*. CRC Press, Washington. pp. 15-85. [Details of morphology, anatomy, cytology, polyploidy breeding are covered in this chapter].

Ravindran, P.N., Nirmal Babu, K. and Sivaraman, K. (2007). *Medicinal and Aromatic Plants – Industrial Profiles: Turmeric: The Genus Curcuma*. CRC Press, Washington, 484p. [A multi- authored volume on various aspects reviewing the information available on turmeric].

Ruby, A. J., Kuttan, G., Dinesh Babu, K., Rajasekharan, K. N. and Kuttan, R. (1995). *Antitumor and Antioxidant Activity of Natural Curcuminoids.* Cancer Letter, 94: 79–83. [This article gives the composition of turmeric besides explaining the antioxidant properties].

Shishodia, S., Sethi, G. and Aggarwal, B. B. (2005). *Curcumin: Getting Back to the Roots*. Annals of New York Academy Sciences, 1056: 206–217. [This article provides information on the molecular basis of the medicinal properties of turmeric].

Sivaraman, K. (2007). *Agronomy of Turmeric. Medicinal and Aromatic Plants – Industrial Profiles: Turmeric: The Genus Curcuma.* CRC Press, Washington. Pp 129-154. [Details of cultivation practices and crop management are described].

Velayudhan, K.C., Muralidharan, V.K., Amalraj, V.A., Gautham, P.L., Mandal, S. and Dineshkumar (1999). *Curcuma*. Genetic Resources, Scientific Monograph No. 4. National Bureau of Plant Genetic Resources, New Delhi, 149p. [A monograph on the genetic resources collected and maintained in the institute under Indian Council of Agricultural Research, New Delhi].

Weiss E.A. (2002). *Spice Crops.* CABI International, Wallingford, UK. 299p. [Family wise description of spice crops belonging to Cruciferae, Lauraceae, Leguminosae, Myristicaceae, Myrtaceae, Umbelliferae and Zingiberaceae. All aspects of cultivation processing and industrial applications are discussed].

Xizhen, A., Jinfeng, S. and Xia, X. (2005). *Ginger Production in Southeast Asia. Ginger: The Genus Zingiber*. In: Ravindran, P. N. and Nirmal Babu, K., eds.: *Medicinal and Aromatic Plants – Industrial Profiles*, CRC Press, Washington, 41. pp. 241-278. [A chapter in the monograph on ginger gives an insight into the production aspects in China].

Zachariah, T.J. (2002). *Ginger*. In: Villupanoor, A. Parthasarathy, Bhageerathy Chempakam and Zachariah, T. J., eds.: *Chemistry of Spices.* CABI International, Wallingford, UK., 70-96. [A volume contributed by many authors for compiling information on spices-derived natural products. The chemical structures of various compounds and their uses are discussed].

Biographical Sketches

Muthuswamy Anandaraj holds a M.Sc. in Botany (1975) from Mysore University and a Ph.D. in Botany (1997) from Calicut University. He has thirty two years of research experience in the field of plantation crops and spices, and headed the Division of Crop Protection, Indian Institute of Spices Research, Calicut, India. His research has mainly focused on epidemiology and disease management. He has developed and released a *Phytophthora* tolerant variety of black pepper in India and studied the mechanism of resistance in that variety.

Dr. Anandaraj is author and co-author of several research papers published in national and international journals and has contributed chapters for several books on spices and edited a few of them. He has also contributed chapters for EOLSS.

Dr. Anandaraj is presently working as Project Coordinator of All India Combined Research Projects on Spices (AICRPS) which is responsible for the formulation of research projects, monitoring and release of location specific varieties and technologies for twelve spice crops in India. He is also coordinating the research conducted on three soil-borne pathogens, *Phytophthora, Fusarium* and *Ralstonia* in 17 institutes under Indian Council of Agricultural Research (ICAR).

Madenur Rangaswamy Sudharshan holds an M.Sc. in Botany (1975), a Ph.D., in Botany (1982) and a Post-Graduate Diploma in Applied Botany (1997) from The Indian Institute of Technology, Khargpur. He has twenty eight years of research experience in the field of spices research, in particular cardamom (small and large), pepper and vanilla. He has worked for twenty three years in the field of agricultural research as head of the Indian Cardamom Research Institute's regional stations.

Dr. Sudarshan's research has mainly focused on crop improvement; he developed and released one selection of cardamom for Karnataka state. He is the author and co-author of more than 60 research papers published in national and international journals, and has contributed chapters for three books on spices. He is presently working as Deputy Director (Research) in the Indian Cardamom Research Institute, Spices Board, Myladumpara, Kerala, India.